Forestry Research West

Forest Service
U.S. Department of Agriculture

May 1980

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A report for land managers on recent developments in forestry research at the four western Experiment Stations of the Forest Service, U.S. Department of Agriculture

In This Issue

Cover

Though the grizzly bear is a powerful and respected animal, it cannot compete with man and his activities. An interagency study team is searching for better ways to manage habitat for the bear, and hoping to ease the conflicts between grizzly and man. Read about it on the facing page.

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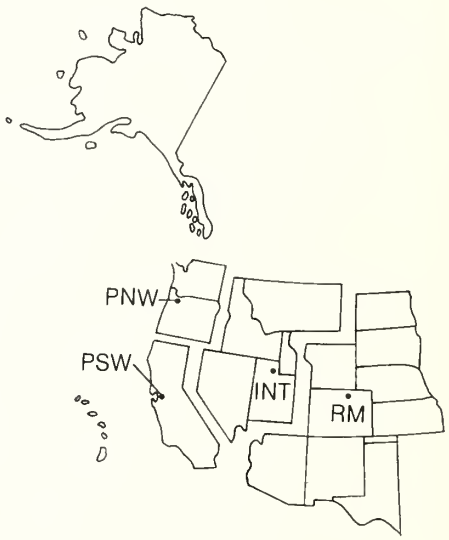


Grizzly!

by Tom Baugh
Intermountain Station

Tattooing a number on a bear's lip. If this bear is trapped again, researchers will be able to identify it and compare data.

This is an animal that cannot compromise or adjust its way of life to ours. For the grizzly bear there is no freedom but that of unbounded space, no life except its own. Without meekness, without a sign of humility, it has refused to accept our idea of what the world should be like. If we succeed in preserving the wild remnant that still survives, the glory will rest primarily on this bear whose stubborn vigor has kept it alive in the face of increasing and seemingly hopeless odds.
-adapted from Robert Porter Allen

Grizzly! The word alone evokes awe. No other animal on the American continent projects such a powerful image of total control. Few Americans, however, have been fortunate enough to see one of these great bears as it moves casually through high mountain meadow grass or stands tall on its hind legs, seemingly the lord of all it surveys. Magnificent? Yes! And yet, this very image of control and environmental dominance is false.

Conflict

For many years now the grizzly has been in retreat. Its range, which once reached from the West Coast to the plains and from Canada to Mexico, is now limited to two relatively small areas of the northern Rocky Mountains. As European man expanded westward, the grizzly found itself in conflict with a force it couldn't always dominate—the weapons and cunning of modern man. The demise of the buffalo and its replacement by domestic cattle and sheep almost sounded the death knell for the grizzly. Year after year the retreat of the great bears continued until finally all that was left to them was the rugged wilderness of the high Rockies. In 1975, the grizzly was declared a threatened species under the Endangered Species Act, and came under special Federal and State protection.

Removing a tranquilized grizzly bear from a "culvert" trap. The scale, suspended from the tree, is used to weigh the bear.

The last bastions of these magnificent animals are centered in Yellowstone and Glacier National Parks. The Parks provide wild environments where grizzly bear can live essentially free from the threat of development. These areas do sustain a great deal of human traffic, but roads, trails, campgrounds, and other recreation facilities occupy only small portions of the Parks, leaving large tracts where bears can live relatively undisturbed. Portions of National Forests classified as Wilderness also provide relatively undisturbed bear range—they receive less human use than the National Parks. And yet, political jurisdictions and manmade geographic boundaries mean nothing to the grizzly. Although severely limited in overall range, the great bears do wander widely over both public and private land—inside and outside Park boundaries.

It has been difficult to assure protection for the bear in areas of National Forests not classified as Wilderness and on State and private lands adjoining Wilderness areas or National Parks. These areas have been (or in the future may be) used for many purposes, including logging, grazing, recreation, and mining. Conflicts between man and bear intensify as man makes further inroads into the bears' range.

Unified effort

Because many jurisdictions were involved, an Interagency Grizzly Bear Study Team was formed in 1973. The Team is composed of members of Intermountain Station, National Park Service, Department of the Interior's Fish and Wildlife Service, Idaho Fish and Game Department, Montana Department of Fish and Game, and Wyoming Department of Game and Fish. Other major cooperators include Montana State University, Bozeman; University of Montana, Missoula; Bureau of Land Management, Department of the Interior; and the Northern, Intermountain, and Rocky Mountain Regions of the Forest Service.

The primary objective of the Team is to learn as much as possible about how to manage areas inhabited by grizzly bear. This research effort has been focused on areas where development is occurring or could occur in the future. Team activities take place in and around Yellowstone National Park in southeast Montana, northwest Wyoming, and southeast Idaho. This area, known as the Yellowstone Ecosystem, is home to one of the largest grizzly bear populations remaining within the continental United States.

Questions

Land managers need to know the kinds and levels of activities humans can pursue in grizzly range without threatening the bear's existence or endangering human lives and property. To determine this, managers must know more about the bear itself. Where do grizzly bear live? What are their food, cover, and space requirements? How many bears are there, and is the population growing, diminishing, or remaining stable? And, finally, can bear and humans coexist?

How do researchers study the wandering, sometimes solitary, and generally touchy grizzly bear? Individual bears are often located by aerial observers in fixed-wing planes who frequently survey portions of the study areas. Once a bear is located, baited traps are moved into the study area, and then observed until a bear is secured. The bear is then anesthetized. While the powerful animal safely slumbers, researchers record a variety of age, growth, sex, and physical conditioning data. The bear is then fitted with a collar containing a radio telemetry device which will allow the bear's movements to be monitored. The bear is also fitted with a metal ear tag, and the lip is tattooed to establish permanent identification.

Radio telemetry has been used in a variety of situations. For example, the movements and daily habits of bears occupying areas scheduled for logging or recreational development are monitored prior to, during, and after development. A comparison of behavior patterns during these three periods provides a sketch of the effects of man-caused modifications of behavior.

Using radio telemetry, and assisted by aircraft observation, researchers are able to identify and then physically follow a grizzly through its daily routine. Information on food habits, locations, denning activities, habitat preferences, breeding activities, and responses to outside influences are gathered in this way. The study team has also structured a unique encounter experience to determine how grizzlies react to human presence and activities. Monitoring bears with radio-instrumented collars, situations are created where the bear is made aware of human presence in his or her area. The bears' reactions are very carefully recorded.

Although the living grizzly is fascinating, the dead bear also contributes significantly to information concerning this species. As part of the comprehensive research effort, all reports of grizzly mortality are verified. Grizzly carcasses are analyzed under established laboratory procedures. The carcasses are weighed and measured; reproductive tracts are analyzed for information on breeding; gastrointestinal tracts are examined for parasitism; skeletons are checked for past injuries; and teeth are sectioned and examined for information on the age of the bear.

The examples of the research just discussed represent only a few of the studies currently underway to determine as much as possible about the grizzly and its relation to its habitat. With an organism as complex as the grizzly and a habitat as intricate as the Yellowstone Ecosystem, many questions remain to be answered. Enough information is available, however, so that researchers are able to make some generalizations.

Early answers

It appears that there are from 300-350 grizzly bear in the Yellowstone Ecosystem. In addition, researchers report that the grizzly is possibly expanding its overall range in nearly all directions from previously known outer perimeters. On the negative side, however, range expansion has led to greater contact with humans with a subsequent likelihood of an increase in bear mortality.

With these generalizations in mind, the study team has recommended that certain land areas be set aside where grizzly bears are given priority over all other possibly conflicting land uses. Another general recommendaton by the team is that if proper control over human-bear conflicts cannot be maintained without the legal aid of the Endangered Species Act, the grizzly should not be removed from threatened classification under the protection of the Act.

In summary, the situation of the grizzly bear, at this time, looks hopeful but much additional work remains to be done. The team has recommended that a system be developed that can be integrated into existing resource management routines to provide an annual population index of the grizzly bear. Included among other recommendations is the continued monitoring of the cumulative and long-term impacts of human-caused habitat manipulations.

It is obvious to most observers that the relationship between man and grizzly will always be somewhat strained. After all, neither of these species is particularly noted for his compromising lifestyle. It is to be hoped, however, that the results of research will indicate pathways which will lead to at least a tolerable coexistence for both species. The Interagency Grizzly Bear Study Team is continuing to work toward that goal.

Checking equipment used to monitor movements of this radio-collared bear.

Managing Sierra Nevada wildlife habitat

by Marcia Wood
Pacific Southwest Station

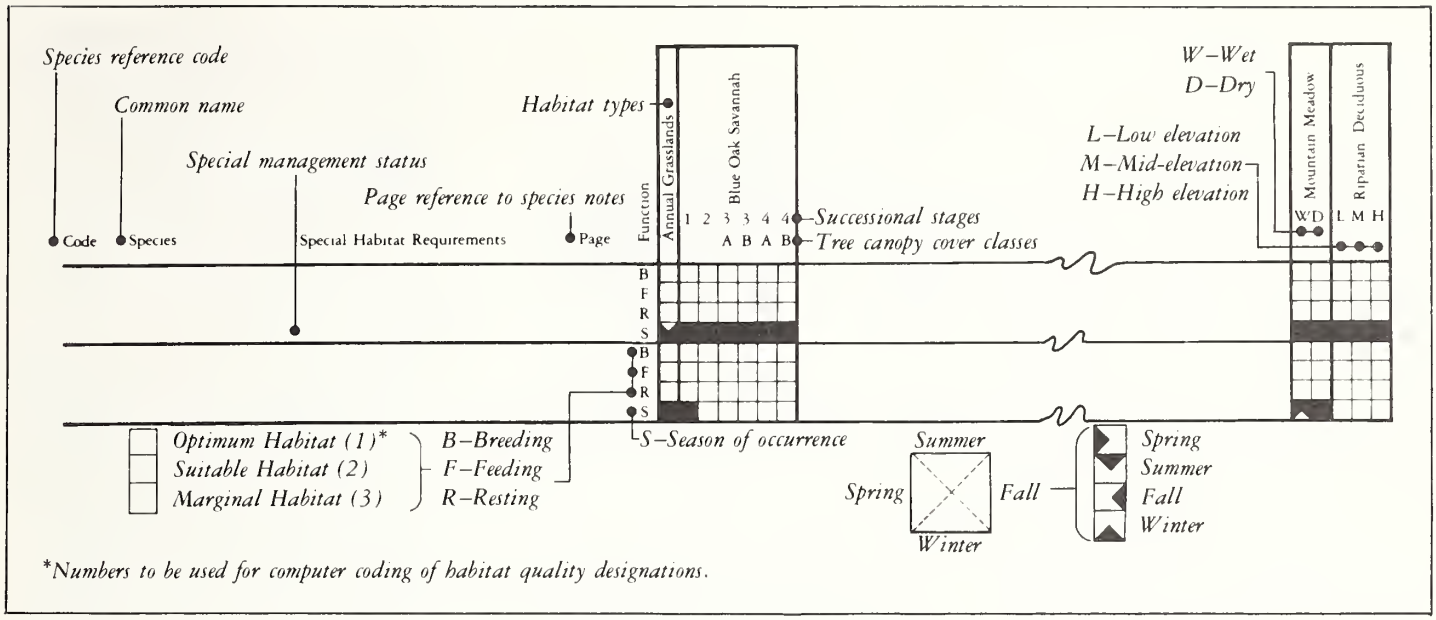
Illustrations by
Ellen Blonder

Most wildlife biologists will agree that the key to managing a wildlife species is to manage its habitat—the surroundings it needs for feeding, mating, resting, or taking cover from its enemies. Now, California biologists, and others concerned with providing adequate habitat for wildlife in the western Sierra Nevada, have a new source of information on the birds, mammals, reptiles, and amphibians of this region. It is the publication, *"California Wildlife and Their Habitats: Western Sierra Nevada."* Research Wildlife Biologist Jared Verner of the Pacific Southwest Station, and Forest Biologist Allan S. Boss, formerly with the Eldorado National Forest in California and now with the Boise National Forest in Idaho, are the technical coordinators of the book. The publication is based on concepts developed by Jack Ward Thomas of the Pacific Northwest Station (see *"A New Outlook for Wildlife,"* Forestry Research West, February 1980), and is probably the most extensive application of this approach that has been made, so far, outside of Oregon.

Designed to serve as a practical working reference, the new California publication presents the best available information on habitat requirements of some 355 wildlife species, from the alpine chipmunk to the yellow-headed blackbird. Included are 208 birds—hawks, owls, woodpeckers, songbirds, geese, ducks, and many more; 94 mammals—bats, rabbits, squirrels, mice, voles, skunks, deer, and others; 27 reptiles (lizards and snakes); and 26 amphibians—salamanders, newts, frogs, toads, and turtles. Basic data from the book are available in computer-readable format through the U.S. Department of Agriculture Computer Center in Fort Collins, Colorado.

Predicting impacts

According to Verner, the book and the computerized data base will give land managers information they need to predict the potential impacts that logging, prescribed burning, brushfield conversion, or any other manipulation of vegetation will have on wildlife species within the Sierra Nevada. Being able to predict impacts will help land managers meet legislative and Forest Service policy requirements that land be managed to support an abundance and diversity of wildlife. In the past, land managers may have been primarily concerned with game animals or rare, threatened, endangered, or sensitive species. The new requirements mean that the commonly occurring species now must receive a share of this attention.



The matrices serve as a handy guide to the requirements of each animal.

For each species, the publication includes a pen-and-ink sketch, life history notes, and a map showing distribution. But the feature Verner and Boss regard as the single most important part of the publication is a series of matrices that compresses information about the species and their habitats into a tabular format that can be read at a glance. "The value of the matrices is that they can help show the biologist how each species that occurs on a National Forest might benefit, or might be harmed by, a proposed management activity," Verner says. Bob Nelson, formerly Director of the Fisheries and Wildlife Management Staff for the National Forests of California (Pacific Southwest Region) and now Deputy Director of the National Forest System's Wildlife and Fisheries Staff in Washington, D.C. explains it this way, "With the wildlife habitat relationships data, I can say to a land manager, 'You tell me what you are doing to the vegetation, and I'll tell you what should happen to several hundred species of wildlife.' "

Although use of the matrix format takes some study, it is relatively easy to master. The matrix presents key pieces of information about the species' habitat requirements. Every major habitat type in the Sierra Nevada is included—annual grasslands, blue-oak savannah, digger pine-oak woodland, chaparral, ponderosa pine, black oak woodland, mountain meadows, riparian deciduous, mixed-conifer, Jeffrey pine, red fir, lodgepole pine, and alpine meadow. The forested types are further defined into successional stages—from stage 1—the grass-forb stage—through stage 4—the large tree stage. Canopy closure classes, ranging from less than 40 percent to more than 70 percent canopy cover, are also indicated. Further designations are provided for the chaparral, mountain meadow, and riparian deciduous types. Chaparral is classified into either grass-forb, light shrub, or dense shrub stages. Mountain meadows are either wet or dry, and the riparian deciduous zone is divided into low-, mid-, or high-elevations.

The matrix notes any special habitat features that a species may require, such as ponds, lakes, or marshes; cliffs, caves, or crevices; or logs, litter, or snags. It indicates, for example, that the black-backed three-toed woodpecker requires "trees infested with wood-boring insects"; that "wet and moist areas with some herbage" are a must for the long-tailed vole; and that "rock outcroppings and well-aerated soil for breeding" are required by the western fence lizard.

The matrix indicates whether a vegetation type is used for breeding, feeding, or resting. Color codes show if the habitat is "optimum," "suitable," or "marginal." The seasons in which each habitat type is used are noted. The reader can also determine whether a species has been officially listed as endangered, rare, or sensitive, or is otherwise of special interest.

Verner's admittedly conservative estimate is that the matrices provide more than 175,000 bits of information, which is why the data base was computerized. The computer program makes it possible to perform analyses that would be difficult, if not impossible, to handle with the paper-and-pencil approach.

Three canopy closure classes are included in the matrices, and are used to further define forest habitats. A "3B" stand, for example, would have poles and medium-sized trees (successional stage 3) with 40 to 69 percent canopy cover (canopy class B).

Using the matrix

Entries for the green-tailed towhee are representative of the types of information the matrices provide. By following the entries from left to right, the reader is given a cross-reference to the life history notes, and then to the towhee's special habitat requirements (dry, brushy slopes with little or no tree canopy). The reader learns that the towhee occurs in certain successional stages of eight different habitat types, ranging from chaparral through lodgepole pine. Of the chaparral habitats, the "dense shrub stage," in which the canopy cover is 50 percent or greater, provides "optimum" habitat in spring and summer for all activities—breeding, feeding, and resting. The "light shrub stage," which has less than 50 percent cover, is used in spring and summer and is "suitable" habitat for all activities. The section for the grass-forb stage of chaparral habitat is blank, indicating that the towhee does not use this successional stage. From this information, the reader now knows that any proposed change in the chaparral cover, such as clearing a dense brushfield, could affect the towhee. Reading further, the columns on lodgepole pine indicate that a stage 2 lodgepole forest—the shrub-seedling-sapling stage—provides "optimum" habitat spring through fall for breeding, resting, and feeding, while the stage 3A forest (pole through medium tree stage with less than 40 percent tree canopy cover) is only "marginal" habitat for those activities spring through fall. Stage 4A lodgepole—the large tree stage with less than 40 percent canopy cover, is also "marginal." From this, the reader has an indication of how an activity such as cutting a stage 4A stand and allowing the site to regenerate would change towhee habitat. Verner explains, "If you know the vegetation type that exists before your management activity takes place, and the vegetation type that will probably be there afterwards, you can use the wildlife relationships data to determine how towhees, or any other species that occur in your area, will be affected."

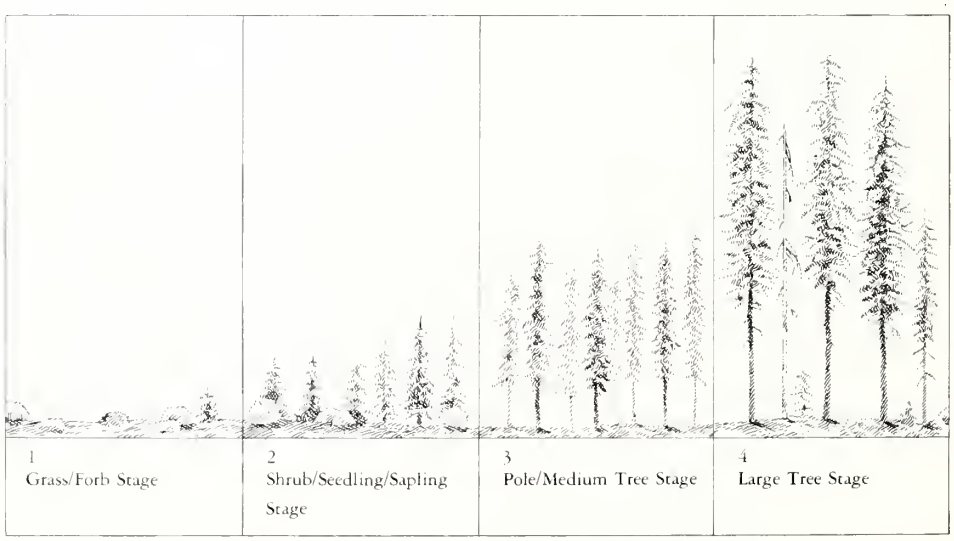
For the biologist who is not already familiar with the details of the habitat requirements of the towhee, or the hundreds of other species covered by the matrices, the matrix format is one of the fastest ways of learning this information. Biological Planner Steve Egeline of the Sierra National Forest's land-use planning team says having the publication for a reference makes his job "infinitely easier. It's extremely useful to have all the information I need in one place. With the wildlife habitat relationships system, it's now possible to account for all the species on the Forest."

Evaluating a timber sale or other proposed project requires more than just consulting the matrices. Verner and Boss recommend that the data be checked in the field. A biologist, for example, should check a project site to see if it includes the special habitat features required by certain wildlife, and should verify whether these species do indeed inhabit the site.

Computerized data base

Most of the data that are in the publication are also available in computer-retrievable form, with the exception of the life history notes and the sketches. Among forest biologists in the western Sierra Nevada region (this includes the Lassen, Plumas, Tahoe, Eldorado, Stanislaus, Sierra, and Sequoia National Forests), Forest Biologist Tom Newman of the Plumas National Forest has probably been one of the most frequent users of the computerized data base. He's used it to analyze timber management plans for some 20 different compartments, averaging between 5,000 and 6,000 acres each. He's also used it to predict changes that could occur over a 100-year-period in spotted owl and goshawk habitat.

For forests and chaparral, the matrices indicate the successional stages that wildlife species use.



"The program narrows down the problem of trying to predict effects," Newman says. "It not only gives you the big picture, but also helps you pick the species you need to focus on. For example, when I'm doing an analysis of a timber compartment, I commonly wind up with a list of around 200 species that the computer says could occur there. I can use the computer as a screening device, to see how cutting or thinning a stand, or changing the vegetation in some other way, might affect each of these species."

The responsibility for maintaining the computerized data base and for teaching forest biologists how to use it belongs to Wildlife Biologist Jan Hurley of the Pacific Southwest Region's Fisheries and Wildlife Management Staff. Jan, who is currently experimenting with new computer applications of the system, says, "Many of us who have worked with the wildlife habitat relationships system feel it is just about the most exciting thing that has ever happened in wildlife biology. It's innovative, and it has captured the attention of the management world."

The computerized data base will be updated and improved, to incorporate newer and better information about the Sierran species. The initial information was the best available, but it has limitations. For example, much of the information was not based on field work, but compiled from the literature. And, although the literature search was "extensive," it was not "exhaustive." The group of 12 experts that collaborated in writing sections of the book often had to rely on their field experience and made "best guesses" about the requirements of some species. Dr. Marshall White of the University of California at Berkeley, who was in charge of the section on mammals, frankly admits, "Our work is a starting point—it presents a series of hypotheses about habitat requirements that must be tested by detailed field studies."

The habitat needs of the marsh hawk and some 200 other birds are described in the publication.

Studies underway by Verner's research team in Fresno, California, will be one source of new field data for verifying and modifying the computerized information. The team's current study of birds in digger pine-blue oak woodlands and in logged mixed-conifer forests, for example, will provide excellent checks of the information presented in the publication and data base.

State-wide program

The Western Sierra Nevada book and computerized data are one part of a State-wide Wildlife Habitat Relationships Program, which will eventually provide habitat data for all National Forest land in California, as well as for several other ownerships. Cooperating in this project are the California State Department of Forestry and Fish and Game,

Information about the black-tailed jackrabbit and the other species in the chapter on mammals is based on previously published material and on the authors' field experience.

Nevada Department of Fish and Game, the Fish and Wildlife Service and Bureau of Land Management of the U.S. Department of the Interior, and Southern California Edison Company. Coordinator for the Program is Hal Salwasser of the Fisheries and Wildlife Management Staff, Pacific Southwest Region. He predicts that "in a year or two, people will accept utilization of the matrices as a standard operating procedure."

Data from the Sierra Nevada, along with that from other parts of the State, will eventually be used for all California National Forest management plans, and all environmental assessments of timber sales. The information will also be used in the Pacific Southwest Region's work with the State Department of Fish and Game in managing deer habitat, in analyses of range allotments, and in evaluations of the amount of old-growth habitat available for species that are partially or totally dependent on this type.

The Wildlife Habitat Relationships Program in California was initiated by Bob Nelson, during the time he was Wildlife and Fisheries Staff Director for California National Forests. Nelson says the new Western Sierra Nevada publication "brings together all the pertinent information and puts it in one place." Along with Verner and Boss, he sees it as "the best single source available for helping California forest managers assess the effects of habitat modification on Sierra Nevada wildlife."

NOTE: Copies of "California Wildlife and Their Habitats," General Technical Report PSW-37, will be available this summer from the Publications Section, Pacific Southwest Station. Further information on use of the computerized data base is available to Forest Service specialists by contacting Jan Hurley, Pacific Southwest Region, (415) 556-8551 (FTS-556-8851) or by writing to her at the Pacific Southwest Region, 630 Sansome Street, San Francisco, California 94111.

Helping rare native trout in the Southwest

by Phil Johnson
Rocky Mountain Station

One of the most popular sport fishes in North America is the trout. While there are several varieties of trout in the West, the evolutionary history is not completely known. Biologists used to think that all western trout evolved from two major lines: the rainbow trout, *Salmo gairdneri,* and the cutthroat trout, *Salmo clarki.* Studies have shown, however, that several species represent evolutionary lines distinct from the rainbow and the cutthroat.

Two of these unique species—the Arizona trout, *Salmo apache,* and the Gila trout, *Salmo gilae*—are being studied by John Rinne, Rocky Mountain Station fisheries biologist, at the Forestry Sciences Laboratory in Tempe, Arizona. Pure populations of these two southwestern trout have been almost eliminated from their native ranges.

Rinne says, "Indiscriminate stocking of millions of rainbow trout into nearly every habitable water in the West, and their subsequent hybridization with native trout, are major reasons for extreme reductions in the range and numbers of native species. Widespread introduction of brown trout, *Salmo trutta,* and brook trout, *Salvelinus fontinalis,* has also had an impact because they compete with native trout for limited food and living space. As a result, we now recognize the Gila trout as an endangered species and the Arizona trout as a threatened species."

Gila trout were historically known to inhabit the headwaters of the Gila River in New Mexico and the Verde River in Arizona. The historic range of the Arizona trout included the headwaters of the Black, White, Blue, and Little Colorado Rivers in Arizona. Today, natural, pure populations of both species are limited, primarily, to small headwater streams of the Black, White, Gila, and San Francisco Rivers. Rinne explains, "If it weren't for barriers such as waterfalls or dry sections of stream that have stopped upstream movement of introduced species, we might not have any populations of native trout."

Electrofishing is one method used to develop estimates of native trout populations, and to assess the importance of different kinds of habitat.

Rinne's research is directed at determining the distribution and the habitat requirements of the Gila and Arizona trouts. His work is closely coordinated with recovery programs for both species. These programs are conducted by a multiagency team working under the direction of the U.S. Fish and Wildlife Service, and within the guidelines of State and Federal permits. Although studies are still in progress, some results are available that have management implications.

Distribution

Prior to making a habitat analysis for native trout, it is necessary to determine the location and purity of existing populations. This information provides an accurate picture of the current status of the fish, and the need and opportunities for recovery efforts.

Standard taxonomic techniques and, more recently, biochemical techniques were used between 1977 and 1979 to examine stream populations of Arizona trout at more than 40 locations in Arizona's White Mountains. The studies identified nearly 20 pure populations. The interagency Recovery Team recommends that 30 self-sustaining pure populations be established before this fish is removed from the threatened species list.

Similar studies are underway in the headwaters of the Gila River to confirm the identity of several suspected populations of the endangered Gila trout. Whether or not these fish are true Gila trout, or hybrids, is yet to be determined.

Habitat

Habitat requirements for Gila trout have been well documented. Rinne believes the requirements for Arizona trout are nearly the same.

Rinne says his research shows that water volume, protective cover, and water depth are key habitat elements that account for almost half of the variability in Gila trout numbers and total fish biomass.

A Gila trout.

An Arizona trout.

In both pools and riffles, more water means greater numbers of fish and greater total weight of fish produced. Pools show a higher level of productivity per square meter of surface area, and per cubic meter of volume, than do riffles. These results suggest that downstream reaches of some creeks and rivers, with their larger streamflows, might offer favorable habitat for native trout.

Rinne's studies show that cover, in the form of rocky nooks, logs, overhanging banks, and streamside vegetation, is next in importance to water volume in contributing to Gila trout productivity. Both riffle and pool habitats are benefited by ample protective cover.

Pool depth has a lot to do with the size of individual Gila trout. The deeper the pool, the bigger the fish—if other habitat elements are favorable. This could be an important factor in developing sport fishing opportunities, should the Gila trout recover to the point that fishing is permitted. (Fishing for endangered species is prohibited.)

This artificial log barrier was installed to prevent upstream movement of non-native trout into native trout waters.

During the summer of 1978, this stream almost dried up during drought - an indication of the extremely harsh conditions under which native trout in the Southwest may persist.

The spawning habitat of the Gila trout has been described in three streams in New Mexico. In general, spawning begins in April at lower elevations and persists into June at higher elevations. Spawning starts at water temperatures around 8° C, and most activity occurs between 1 and 4 p.m. Redds, or spawning nests, are situated in gravel and small pebbles, usually near some form of cover in water that is 5 to 15 centimeters deep. The timing and habitat selected for Gila trout spawning are nearly identical to rainbow trout. This explains, in part, the widespread hybridization between the two species.

Habitat requirements are important when selecting streams suitable for reintroducing native trout to restore their numbers and range. Candidate streams, particularly at higher elevations, often appear to be ideal trout habitat at certain times of the year. But, these conditions may disappear at other times, such as the drought period common in the arid Southwest during early summer. In addition, harsh winter conditions may cause ice to form on the bottom of the stream, destroying food supplies; or, heavy snow may clog small streams, causing suffocation. All these factors must be considered so that "surprises" don't destroy fledgling populations of reintroduced native fish.

Competition

Temperature tolerances for the two natives, and for rainbow, brown, and brook trouts, are remarkably similar. Research has shown, however, that non-native species can out-compete native species for food and space within this temperature range.

For example, field and laboratory studies have documented a more aggressive behavior for brook and brown trout compared to Arizona trout. In a habitat favorable for Arizona trout, these non-natives are first to consume limited food supplies, and they drive the natives away from the best hiding, resting, and feeding spots.

Hope for the future

Rinne believes his research, coupled with findings from other agencies cooperating in the recovery programs, hold high promise for restoring healthy, productive populations of native trout in the Southwest.

Recent experience suggests that Arizona trout can do well in mountain lakes, reaching sizes of 18 inches or better and creating a potential new opportunity for "quality" sport fishing. From his comparative habitat studies, Rinne thinks that the endangered Gila trout might also fair well in certain lakes — someday becoming an additional candidate for sport fishing.

If you would like to know more about the native trout research at the Tempe lab, contact John Rinne, Forestry Sciences Laboratory, Arizona State University, Tempe, Arizona 85281. Phone (602) 261-4365, FTS-261-4365.

Publications

Wood for energy

The vast quantities of wood fiber in the Pacific Coast States that are currently underutilized have generated a good deal of interest as possible sources of energy. But physical availability of the material is not the only issue, according to Resource Analyst Jim Howard of the Pacific Northwest Station. Economics is the overriding factor. The product must be competitive and profitable.

In a report written for a wide audience of resource managers and planners, both public and private, Howard reviews the many factors that determine the feasibility for converting wood biomass into energy. He examines the technologies of converting wood to energy, the availability of wood, problems and costs involved in its transportation and storage, and current political factors which influence the situation, such as marketing, long-term supplies, and tax structure. Most of the data for the report have been drawn from Oregon, but most of the conclusions apply to Washington and California as well.

Significant opportunities to expand supplies of electricity exist in forest industry plants of the Pacific Northwest where large volumes of residue are now used to produce steam. Electricity could be generated by adding unused residues to those now used for boiler fuel. And the cost for electricity from this source would be less than at a central power plant. Such co-generation of power might be feasible for clusters of mills close to each other where it was not for single mills.

Copies of *"Wood for Energy in the Pacific Northwest: An Overview"* by James O. Howard, General Technical Report PNW-94, are available from the Pacific Northwest Station.

The values of clear air

Air pollution and its effects on atmospheric visibility are becoming topics of increasing concern. In January, 1979, scientists and administrators from government agencies, private industry, universities, and special interest groups got together to discuss various aspects of establishing the value of clear air in support of the national visibility protection goal, established by the Clean Air Act.

Papers presented covered: economic assessments, behaviorial and social perspectives, physical and psychophysical considerations, management perspectives, plus other areas.

If you would like a copy of the proceedings, which also include a bibliography of relevant papers, write the Rocky Mountain Station and request *"Proceedings of the Workshop in Visibility Values,"* General Technical Report WO-18-FR22.

Fitting the aquatic system into land use planning

Researchers at the Intermountain Station have developed a method to integrate streams and their fisheries into the Land Systems Inventory, a major tool for decisionmaking on National Forest lands. The new method applies at the landtype and landtype association levels and includes most streams and their fisheries.

The Intermountain Station report, *"Including the Fishery System in Land Planning,"* GTR-INT-60-FR22, demonstrates the method that might work over broad areas of mountainous land. The report is based on a study that successfully integrated the fishery into a Land Systems Inventory covering 397 square miles along the South Fork of the Salmon River in Idaho.

Author William S. Platts, fishery biologist, says, "To assign streams for resource use, managers need information similar to that required to allocate lands as provided in the Land Systems Inventory. Managers must know the inherent capability of streams, the resources the streams produce, and the influences on these stream resources from surrounding land management programs."

The basic framework outlined in Platts' report can also be used to enter the fishery system into lower levels of the Land Systems Inventory as they are developed.

Copies of the report are available from the Intermountain Station.

Thinning ponderosa-Jeffrey pine plantations

Levels for precommercial thinning of ponderosa and Jeffrey pine plantations in northeastern California are evaluated in a new report from the Pacific Southwest Station. Research Forester William W. Oliver of the Station's Redding, California, Silviculture Unit, monitored a plantation on the Modoc National Forest for this study. The plantation was located on the west slope of the Warner Mountains, and had a site index of 50 feet at 50 years. Trees were initially planted at 8- by 8-foot spacings; early survival and growth was good. The plantation was thinned at between 28 to 30 years of age, to stocking levels ranging from 13 to 86 square feet of basal area per acre.

Two features of Oliver's study make it especially useful. First, he follows stand response for a longer period (15 years after thinning) than most other investigators. Second, he evaluates the common practice of conducting only a single precommercial thinning; most available data concern stands that have been precommercially thinned several times.

Stand measurements, which were taken approximately every 5 years for 15 years following thinning, indicate that a basal area of 110 square feet per acre is optimum for timber production in the plantation. This figure represents nearly maximum volume production from a minimum amount of growing stock, according to Oliver. Using this performance data, he estimates that by 1984-1986—or 25 years after the precommercial thinning—trees in the plantation should average 12 inches in diameter—a merchantable size. The plantation should have a basal area of about 126 square feet per acre. A commercial thinning, removing 34 square feet per acre, would leave 92 square feet of basal area per acre, a density that Oliver says is "optimum for continued volume production on a 10-year commercial thinning cycle." About 1200 board feet of merchantable material per acre could be produced.

Further information about the study is in Research Paper PSW-141, *"Fifteen-year Growth Patterns After Thinning a Ponderosa-Jeffrey Pine Plantation in Northeastern California,"* by William W. Oliver. Copies are available from the Pacific Southwest Station.

Calculator on the fire line

This year, many fire managers will carry a most unusual tool to the site of a wildfire. The tool—a handheld calculator—is equipped with a custom-designed program that can be used to predict such things as fire intensity, rate of spread, and the probability that windborne embers will ignite new fires. It can also be used to calculate the National Fire Danger Rating System indices.

The special program for the calculator was developed by researchers of the Intermountain Station's Fire Behavior Research Work Unit at the Northern Forest Fire Laboratory, Missoula. Spearheaded by Research Forester Robert Burgan, the development condenses years of fire research by many individuals into a convenient tool for field application.

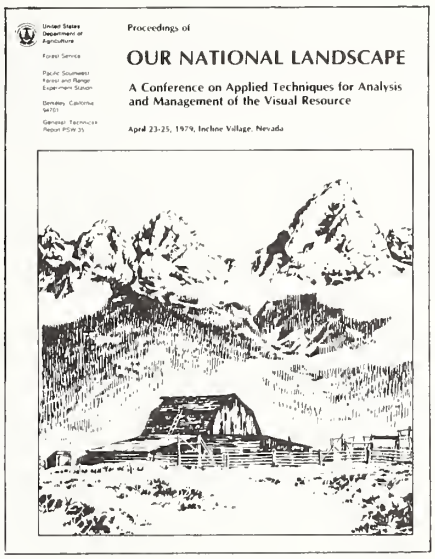
Using the calculator, fire managers can predict fire behavior at a fire site in a few minutes. Although it can be done manually, the calculator can accommodate changes in windspeed or fuel moisture in seconds while manual interpretation requires constant repetition and much more time.

The Intermountain Station report, *"Fire Danger/Fire Behavior Computations with the Texas Instruments TI-59 Calculator: User's Manual,"* GTR INT-61-FR22, includes operating instructions and a discussion of the limitations of the system. Write to the Intermountain Station for a copy.

New forest engineering glossary

Swamp, span, swell, and swing are words that have special meanings in forest engineering. They are among the nearly 600 words which appear in a new 24-page glossary of terms used in transportation, construction, and silviculture as well as forest engineering. Terms in the new publication were selected to be adaptable to foreign translation and usage to facilitate worldwide communication in this rapidly advancing field of technology.

Curiosity about the special meanings of swamp, span, swell, and swing can be satisfied by writing to the Pacific Northwest Forest and Range Experiment Station for a copy of *"Glossary of Forest Engineering Terms,"* by Ronald W. Mifflin and Hilton H. Lysons, order # 79095. The new publication is a comprehensive replacement of a glossary published by the Pacific Northwest Station in 1969.



Management of "visual resources"

Scenery is a resource that can—and should be—managed just like any other natural resource. This is the premise behind what is becoming known as "visual resource management"—the practice of managing and maintaining the attractiveness of wildland landscapes. New developments in visual resource management are described in the proceedings of the "Our National Landscape" conference, which was held in Nevada in 1979.

The Proceedings cover almost every major aspect of visual resource management. Authors of the more than 100 papers presented represent a variety of professional and technical backgrounds from private industry, several levels of government, and research organizations. They are researchers, who discuss the results of their studies, and are land managers, who describe how they met the landscape management problems posed by surface mining operations, development of ski areas, harvesting of timber, construction of highways, and other projects.

Also presented are papers on the technology available for solving landscape management problems, including computerized techniques and other approaches. Legal aspects of landscape management and areas in which more research is needed, are examined.

The conference co-chairmen, Gary H. Elsner and Richard C. Smardon, formerly of the Pacific Southwest Station's Land-Use Planning Research Unit, compiled the Proceedings. Copies may be obtained from the PSW Station by requesting General Technical Report PSW-35, *"Proceedings of Our National Landscape—A Conference on Applied Techniques for Analysis and Management of the Visual Resource."*

Landscape inventory system developed

Two California landscape architects have developed a new system for inventorying scenic resources in wildland areas. One of the major advantages of their classification scheme is that it can be used for describing areas of almost any size—from small settings of several square miles to regions covering thousands of acres.

The inventory system was developed by R. Burton Litton, landscape architect with the Pacific Southwest Station and professor of landscape architecture at the University of California, Berkeley, and by Robert J. Tetlow, who is also a landscape architecture professor at the University. Their recently issued report, *"A Landscape Inventory Framework: Scenic Analyses of the Northern Great Plains,"* Research Paper PSW-135, describes the system. Copies of the report are available from the Pacific Southwest Station.

Although the Northern Great Plains, a region in which flat glasslands predominate, was used in developing the inventory framework, the system is applicable to other landscapes as well, including mountain forests, hill rangelands, and riparian ecosystems.

It can be used for broad area planning, design and management of small areas, and related uses. The framework was designed to give land-use planners, landscape architects, and others, a convenient method for documenting scenic resources. This information can be used with other natural resources data in judging landscape values and in predicting the visual impacts of proposed land management projects.

The inventory framework has four hierarchical levels—the landscape continuity, province, unit, and setting. These are described in the report, and samples of each are given. An area of about 15 square miles, surrounding Devils Tower National Monument, is used as an example of a landscape setting; the case study area in its entirety—the 4-State, 250,000-acre Northern Great Plains region—illustrates the landscape continuity.

The researchers reviewed 11 other landscape inventory systems in designing their framework. Among these was the widely used system Litton developed in 1968 for describing and inventorying forest landscapes. This earlier system is expanded in the new report.

Litton and Tetlow also evaluated a combination of aids in the project, including satellite imagery, photos taken from the ground and from low-flying aircraft, and topographic maps. These were supplemented by field sketches. Samples of these aids, and the authors' recommendations on the usefulness of each, are included in the report.

Ponderosa pine regeneration

Throughout most of its range, natural regeneration of ponderosa pine (*Pinus ponderosa Laws.*) is usually slow and frequently uncertain. Successful forest management requires either prompt regeneration following harvest cutting or the establishment of advanced reproduction.

Much research has been devoted to ponderosa pine regeneration problems, but most of these studies have failed to answer two important concerns: (1) Where in the pine stand are the most influential environmental factors working? (2) How do various parts of the pine forest (canopies, litter, boles, etc.) affect these factors?

A new publication issued by the Intermountain Station undertakes to provide this information. Michael G. Harrington, research forester at the Rocky Mountain Station, and Rick G. Kelsey, Wood Chemistry Lab, University of Montana, conducted the study to determine the effects of various environmental factors on ponderosa pine germination and seedling establishment and growth.

They selected a study site 40 miles northeast of Missoula that includes about 14 acres of level ground on the Blackfoot-Clearwater Game Range. Field plots were established in the summer of 1974 and involved two major treatment groups. The first group of plots was situated within a ponderosa pine stand, and the second group was in large openings near, but not under, the direct influence of the stand.

Results show that seed germination was significantly greater in the opening plots. Overstory canopy and forest floor restricted the amounts of precipitation, light, and heat reaching the soil, and probably decreased germination. The largest seedlings occurred in the fire-treated plots.

The publication *"Influence of Some Environmental Factors on Initial Establishment and Growth of Ponderosa Pine Seedlings,"* RP INT-230-FR22, contains a complete discussion of the methods and results of the study. Write to the Intermountain Station for a copy.

Birds and logging

Forest bird populations are highly dependent on the surrounding vegetation. As the vegetative structure of a habitat changes, the number of different bird species can be expected to change.

Scientists at the Rocky Mountain Station, along with cooperators at Northern Arizona University, recently completed studies on the effects of timber harvesting on nongame bird populations in ponderosa pine forests.

Their findings show that, by following strict guidelines, forest managers can remove between one-sixth and two-thirds of the available foliage without detrimentally affecting the breeding bird community in terms of richness, density, and diversity.

To learn more about recommendations for maintaining or increasing bird populations in managed ponderosa pine forests, write the Rocky Mountain Station and request *"Effects of Harvesting Ponderosa Pine on Nongame Bird Populations,"* by Robert C. Szaro and Russell P. Balda, Research Paper RM-212-FR22.

What's it worth?

The University of Arizona, along with the Rocky Mountain Station, recently sponsored two symposia to help find ways to better understand and assess the noncommodity benefits of forests and rangelands, such as scenic beauty, nongame wildlife, wilderness, and clean air and water.

Increasing awareness of the importance of these products has revealed a lack of adequate information and methodology for comparing these values with commodity values such as wood fiber and livestock forage.

Participants at the symposia presented papers to help overcome this problem. Papers covered: preferences for landscape modification; obtaining and sharing information; man-made structures in natural settings; the value of fish and wildlife resources; the use of survey instruments; dispersed recreation experiences; conceptual typing of trail environments; and more.

For your copy of *"Assessing Amenity Resource Values,"* write the Rocky Mountain Station and request General Technical Report RM-68-FR22.

The future of cedar

Shake and shingle manufacturers in Oregon and Washington are likely to be the first to feel the pinch as the supply of old-growth western redcedar becomes scarce on private forest lands. This long-lived, disease-resistant species is being harvested in the United States—particularly Oregon and Washington—twice as fast as the annual growth rate. Eventually other industries that use cedar will also have supply problems. It is uncertain whether the tremendous volume of cedar still left in British Columbia can be made available in the United States in the desired quantities.

Although young-growth cedar is suitable for some products, the amount available in the future will be considerably less than is now being consumed. And very little cedar is being planted, although some restocks naturally in logged areas.

The consumption rate and prices for western redcedar have risen more sharply in the past 10 years than for most other western softwoods. The average annual increase in the price of western redcedar logs was 15 percent from 1965 to 1977, compared with 12 percent for Douglas-fir and hemlock logs.

A recent report provides information about trends in supply, products, prices, and ownership of cedar and is designed to answer the questions of cedar products manufacturers, resource managers, legislators, and others who must make decisions about the future of the species.

Copies of *"Western Redcedar—A Forest Resource in Transition"*, Resource Bulletin PNW-85, by Charles L. Bolsinger, are available from the Pacific Northwest Station.

New wood resources program

A new Research and Development Program has begun at the Intermountain Station. The Program—Systems of Timber Utilization for Environmental Management (STEM)—will provide land managers with methods to use more of the presently underutilized wood resources of the Rocky Mountains. The effort is also designed to develop specific timber harvesting recommendations to help achieve management of nontimber resources in small timber or other marginal stands. Watershed protection, wildlife habitat, esthetics, and insect and disease control have become important management goals in such stands.

The STEM Program is headquartered at the Intermountain Station's Forestry Sciences Laboratory, Missoula. The research program will include core units on economics, engineering technology, and timber harvesting technology. In addition, Station researchers in the physical and biological sciences will participate in aspects of the program. Forest Service personnel of the Intermountain and Northern Regions and cooperators from universities in the Rocky Mountain area will also participate.

Ron Barger, Missoula, who has had 25 years of research experience and has published extensively on forest products utilization, is heading the STEM Program. Michael J. Gonsior, also of Missoula, has been named Project Leader of the unit dealing with timber harvesting and utilization technology. Project Leader Ervin G. Schuster, Missoula, will guide the economics unit. Edward R. Burroughs, Jr., of the Station's Forestry Sciences Laboratory, Bozeman, is Project Leader of the unit concerned with engineering technology.

The STEM Program will emphasize extension and application of research results at hand, and of research currently underway. A dominant aspect of the program will be the selection and development of field sites as research-demonstration areas. Each site will represent a major small-timber management problem typical of the region in which it is located.

You'll find good reading in our August issue. We'll cover clearcutting and fire studies in larch/Douglas-fir forests in western Montana; look at ways to control seed and cone insects; check on how scientists are helping migrating mule deer cope with crossing highways; plus review some new research publications; and more. Don't miss it!

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